

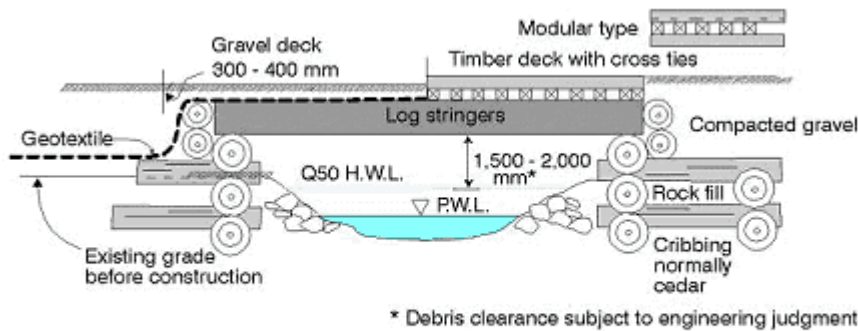
## *Protect waterways*

### Temporary Stream Crossings

#### Construction Site Storm Water Runoff Control

##### Description

A temporary stream crossing is a structure erected to provide a safe and stable way for construction vehicle traffic to cross a running watercourse. The primary purpose of such a structure is to provide streambank stabilization, reduce the risk of damaging the streambed or channel, and reduce the risk of sediment loading from construction traffic. A temporary stream crossing may be a bridge, a culvert, or a ford.



**Properly installed stream crossings can prevent destruction of stream habitat (Source: British Columbia Ministry of Forests, no date)**

##### Applicability

Temporary stream crossings are applicable wherever heavy construction equipment must be moved from one side of a stream channel to the other, or where lighter construction vehicles will cross the stream a number of times during the construction period. In either case, an appropriate method for ensuring the stability of the streambanks and preventing large-scale erosion is necessary.

A bridge or culvert is the best choice for most temporary stream crossings. If properly designed, each can support heavy loads and materials used to construct most bridges, and culverts can be salvaged after they are removed. Fords are appropriate in steep areas subject to flash flooding, where normal flow is shallow or intermittent across a wide channel. Fords should be used only where stream crossings are expected to be infrequent.

##### Siting and Design Considerations

Because of the potential for stream degradation, flooding, and safety hazards, stream crossings should be avoided on a construction site whenever possible. Consideration should be given to alternative routes to accessing a site before arrangements are made to erect a temporary stream crossing. If it is determined that a stream crossing is necessary, an area where the potential for

erosion is low should be selected. If possible, the stream crossing structure should be selected during a dry period to reduce sediment transport into the stream.

If needed, over-stream bridges are generally the preferred temporary stream crossing structure. The expected load and frequency of the stream crossing, however, will govern the selection of a bridge as the correct choice for a temporary stream crossing. Bridges usually cause minimal disturbance to a stream's banks and cause the least obstruction to stream flow and fish migration. They should be constructed only under the supervision and approval of a qualified engineer.

As general guidelines for constructing temporary bridges, clearing and excavation of the stream shores and bed should be kept to a minimum. Sufficient clearance should be provided for floating objects to pass under the bridge. Abutments should be parallel to the stream and on stable banks. If the stream is less than 8 feet wide at the point a crossing is needed, no additional in-stream supports should be used. If the crossing is to extend across a channel wider than 8 feet (as measured from top of bank to top of bank), the bridge should be designed with one in-water support for each 8 feet of stream width.

A temporary bridge should be anchored by steel cable or chain on one side only to a stable structure on shore. Examples of anchoring structures include large-diameter trees, large boulders, and steel anchors. By anchoring the bridge on one side only, there is a decreased risk of downstream blockage or flow diversion if a bridge is washed out.

When constructing a culvert, filter cloth should be used to cover the streambed and streambanks to reduce settlement and improve the stability of the culvert structure. The filter cloth should extend a minimum of 6 inches and a maximum of 1 foot beyond the end of the culvert and bedding material. The culvert piping should not exceed 40 feet in length and should be of sufficient diameter to allow for complete passage of flow during peak flow periods. The culvert pipes should be covered with a minimum of 1 foot of aggregate. If multiple culverts are used, at least 1 foot of aggregate should separate the pipes.

Fords should be constructed of stabilizing material such as large rocks.

### **Limitations**

Bridges can be considered the greatest safety hazard of all temporary stream crossing structures if not properly designed and constructed. Bridges might also prove to be more costly in terms of repair costs and lost construction time if they are washed out or collapse (Smolen et al., 1988).

The construction and removal of culverts are usually very disturbing to the surrounding area, and erosion and downstream movement of soils is often great. Culverts can also create obstructions to flow in a stream and inhibit fish migration. Depending on their size, culverts can be blocked by large debris in a stream and are therefore vulnerable to frequent washout.

If given a choice between building a bridge or a culvert as a temporary stream crossing, a bridge is preferred because of the relative minimal disturbance to streambanks and the opportunity for unimpeded flow through the channel.

The approaches to fords often have high erosion potential. In addition, excavation of the streambed and approach to lay riprap or other stabilization material causes major stream disturbance. Mud and

other debris are transported directly into the stream unless the crossing is used only during periods of low flow.

### **Maintenance Considerations**

Temporary stream crossings should be inspected at least once a week and after all significant rainfall events. If any structural damage is reported to a bridge or culvert, construction traffic should stop use of the structure until appropriate repairs are made. Evidence of streambank erosion should be repaired immediately.

Fords should be inspected closely after major storm events to ensure that stabilization materials remain in place. If the material has moved downstream during periods of peak flow, the lost material should be replaced immediately.

### **Effectiveness**

Both temporary bridges and culverts provide an adequate path for construction traffic crossing a stream or watercourse.

### **Cost Considerations**

Generally speaking, temporary bridges are more expensive to design and construct than culverts. Bridges are also associated with higher maintenance and repair costs should they fail. Additional costs may accrue to the site team in terms of lost construction time if a temporary structure is washed out or otherwise fails.

### **References**

British Columbia Ministry of Forests. No date. *Forest Practices Code Stream Crossing for Fish Streams Guidebook*. [[www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/stream/figure19.htm](http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/stream/figure19.htm)]. Accessed January 2001.

Smolen, M.D., D.W. Miller, L.C. Wyatt, J. Lichthardt, and A.L. Lanier. 1988. *Erosion and Sediment Control Planning and Design Manual*. North Carolina Sedimentation Control Commission, North Carolina Department of Environment, Health, and Natural Resources, and Division of Land Resources Land Quality Section, Raleigh, NC.

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## Vegetated Buffer

### Construction Site Storm Water Runoff Control

#### Description

Vegetated buffers are areas of either natural or established vegetation that are maintained to protect the water quality of neighboring areas. Buffer zones reduce the velocity of storm water runoff, provide an area for the runoff to permeate the soil, contribute to ground water recharge, and act as filters to catch sediment. The reduction in velocity also helps to prevent soil erosion.

#### Applicability

Vegetated buffers can be used in any area that is able to support vegetation but they are most effective and beneficial on floodplains, near wetlands, along streambanks, and on steep, unstable slopes. They are also effective in separating land use areas that are not compatible and in protecting wetlands or waterbodies by displacing activities that might be potential sources of nonpoint source pollution.



Buffers at the perimeters of construction sites are similar to agricultural buffers in that they trap sediments and remove pollutants in runoff from exposed areas (Source: Nova Scotia Department of Agriculture and Fisheries, 2000)

#### Siting and Design Considerations

To establish an effective vegetative buffer, the following guidelines should be followed:

- Soils should not be compacted.
- Slopes should be less than 5 percent.
- Buffer widths should be determined after careful consideration of slope, vegetation, soils, depth to impermeable layers, runoff sediment characteristics, type and quantity of storm water pollutants, and annual rainfall.
- Buffer widths should increase as slope increases.
- Zones of vegetation (native vegetation in particular), including grasses, deciduous and evergreen shrubs, and understory and overstory trees, should be intermixed.
- In areas where flows are concentrated and velocities are high, buffer zones should be combined with other structural or nonstructural BMPs as a pretreatment.

## Limitations

Vegetated buffers require plant growth before they can be effective, and land on which to plant the vegetation must be available. If the cost of the land is very high, buffer zones might not be cost-effective. Although vegetated buffers help to protect water quality, they usually do not effectively counteract concentrated storm water flows to neighboring or downstream wetlands.

## Maintenance Considerations

Keeping vegetation healthy in vegetated buffers requires routine maintenance, which (depending on species, soil types, and climatic conditions) can include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning. Inspection and maintenance are most important when buffer areas are first installed. Once established, vegetated buffers do not require much maintenance beyond the routine procedures listed earlier and periodic inspections of the areas, especially after any heavy rainfall and at least once a year. Inspections should focus on encroachment, gully erosion, density of vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If there is more than 6 inches of sediment in one place, it should be removed.

## Effectiveness

Several researchers have measured greater than 90 percent reductions in sediment and nitrate concentrations. Buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).

## References

- Gilliam, J.W. 1994. Riparian Wetlands and Water Quality. *Journal of Environmental Quality*. 23:896-900. As cited in Michigan Department of Environmental Quality. 1998. *Guidebook of Best Management Practices for Michigan Watersheds*. Michigan Department of Environmental Quality, Surface Water Quality Division, Lansing, MI.
- Nova Scotia Department of Agriculture and Fisheries. 2000. *Awareness and Communication Project Reports, Appendix E: Photographs*. [<http://www.gov.ns.ca/nsaf/home.htm>]. Last updated January 1997. Accessed January 2001.
- USEPA. 1992. *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices*. EPA 832-R-92-006. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
- USEPA. 1996. *Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices*. EPA 843-B-96-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

## *Phase construction*

### **Construction Sequencing**

#### **Construction Site Storm Water Runoff Control**

##### **Description**

Construction sequencing requires creating and following a work schedule that balances the timing of land disturbance activities and the installation of measures to control erosion and sedimentation, in order to reduce on-site erosion and off-site sedimentation.

##### **Applicability**

Construction sequencing can be used to plan earthwork and erosion and sediment control (ESC) activities at sites where land disturbances might affect water quality in a receiving waterbody.

##### **Siting and Design Considerations**

Construction sequencing schedules should, at a minimum, include the following:

- The ESC practices that are to be installed
- Principal development activities
- Which measures should be installed before other activities are started
- Compatibility with the general contract construction schedule

Table 1 summarizes other important scheduling considerations in addition to those listed above.

##### **Limitations**

Weather and other unpredictable variables may affect construction sequence schedules. However, the proposed schedule and a protocol for making changes due to unforeseen problems should be plainly stated in the ESC plan.



Table 1. Scheduling considerations for construction activities.

| <b>Construction Activity</b>   | <b>Schedule Consideration</b>   |
|--|---|
| Construction access—entrance to site, construction routes, areas designated for equipment parking  | This is the first land-disturbing activity. As soon as construction begins, stabilize any bare areas with gravel and temporary vegetation.  |
| Sediment traps and barriers—basin traps, sediment fences, outlet protection  | After construction site is accessed, principal basins should be installed, with the addition of more traps and barriers as needed during grading.   |
| Runoff control—diversions, perimeter dikes, water bars, outlet protection  | Key practices should be installed after the installation of principal sediment traps and before land grading. Additional runoff control measures may be installed during grading.   |
| Runoff conveyance system—stabilize stream banks, storm drains, channels, inlet and outlet protection, slope drains                           | If necessary, stabilize stream banks as soon as possible, and install principal runoff conveyance system with runoff control measures. The remainder of the systems may be installed after grading.   |
| Land clearing and grading—site preparation (cutting, filling, and grading, sediment traps, barriers, diversions, drains, surface roughening) | Implement major clearing and grading after installation of principal sediment and key runoff-control measures, and install additional control measures as grading continues. Clear borrow and disposal areas as needed, and mark trees and buffer areas for preservation. |
| Surface stabilization—temporary and permanent seeding, mulching, sodding, riprap   | Temporary or permanent stabilizing measures should be applied immediately to any disturbed areas where work has been either completed or delayed.   |
| Building construction—buildings, utilities, paving   | During construction, install any erosion and sedimentation control measures that are needed.  |
| Landscaping and final stabilization—topsoiling, trees and shrubs, permanent seeding, mulching, sodding, riprap                               | This is the last construction phase. Stabilize all open areas, including borrow and spoil areas, and remove and stabilize all temporary control measures.   |

### Maintenance Considerations

The construction sequence should be followed throughout the project and the written plan should be modified before any changes in construction activities are executed. The plan can be updated if a site inspection indicates the need for additional erosion and sediment control.

### **Effectiveness**

Construction sequencing can be an effective tool for erosion and sediment control because it ensures that management practices are installed where necessary and when appropriate. The plan must be followed and updated if needed to maximize the effectiveness of ESC under changing conditions.

### **Cost Considerations**

Construction sequencing is a low-cost BMP because it requires a limited amount of a contractor's time to provide a written plan for the coordination of construction activities and management practices. Additional time might be needed to update the sequencing plan if the current plan is not providing sufficient ESC.

### **References**

Smolen, M.D., D.W. Miller, L.C. Wyall, J. Lichthardt, and A.L. Lanier. 1988. *Erosion and Sediment Control Planning and Design Manual*. North Carolina Sedimentation Control Commission, North Carolina Department of Environment, Health, and Natural Resources, and Division of Land Resources Land Quality Section, Raleigh, NC.

## Dust Control

### Construction Site Storm Water Runoff Control

#### Description

Dust control measures are practices that help reduce surface and air movement of dust from disturbed soil surfaces. Construction sites are good candidates for dust control measures because land disturbance from clearing and excavation generates a large amount of soil disturbance and open space for wind to pick up dust particles. To illustrate this point, limited research at construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction (WA Dept. of Ecology, 1992). These airborne particles pose a dual threat to the environment and human health. First, dust can be carried off-site, thereby increasing soil loss from the construction area and increasing the likelihood of sedimentation and water pollution. Second, blowing dust particles can contribute to respiratory health problems and create an inhospitable working environment.



#### Applicability

Dust control measures are applicable to any construction site where dust is created and there is the potential for air and water pollution from dust traveling across the landscape or through the air. Dust control measures are particularly important in arid or semiarid regions, where soil can become extremely dry and vulnerable to transport by high winds. Also, dust control measures should be implemented on all construction sites where there will be major soil disturbances or heavy construction activity, such as clearing, excavation, demolition, or excessive vehicle traffic. Earthmoving activities are the major source of dust from construction sites, but traffic and general disturbances can also be major contributors (WA Dept. of Ecology, 1992). The particular dust control measures that are implemented at a site will depend on the topography and land cover of a given site, as well as the soil characteristics and expected rainfall at the site.

#### Siting and Design Considerations

When designing a dust control plan for a site, the amount of soil exposed will dictate the quantity of dust generation and transport. Therefore, construction sequencing and disturbing only small areas at a time can greatly reduce problematic dust from a site. If land must be disturbed, additional temporary stabilization measures should be considered prior to disturbance. A number of methods can be used to control dust from a site. The following is a brief list of some control measures and their design criteria. Not all control measures will be applicable to a given site. The owner, operator, and contractors responsible for dust control at a site will have to determine which practices accommodate their needs based on specific site and weather conditions.

- *Sprinkling/Irrigation*. Sprinkling the ground surface with water until it is moist is an effective dust control method for haul roads and other traffic routes (Smolen et al., 1988). This practice can be applied to almost any site.
- *Vegetative Cover*. In areas not expected to handle vehicle traffic, vegetative stabilization of disturbed soil is often desirable. Vegetative cover provides coverage to surface soils and slows wind velocity at the ground surface, thus reducing the potential for dust to become airborne.
- *Mulch*. Mulching can be a quick and effective means of dust control for a recently disturbed area (Smolen et al., 1988).
- *Wind Breaks*. Wind breaks are barriers (either natural or constructed) that reduce wind velocity through a site and therefore reduce the possibility of suspended particles. Wind breaks can be trees or shrubs left in place during site clearing or constructed barriers such as a wind fence, snow fence, tarp curtain, hay bale, crate wall, or sediment wall (USEPA, 1992).
- *Tillage*. Deep tillage in large open areas brings soil clods to the surface where they rest on top of dust, preventing it from becoming airborne.
- *Stone*. Stone may be an effective dust deterrent for construction roads and entrances or as a mulch in areas where vegetation cannot be established.
- *Spray-on Chemical Soil Treatments (palliatives)*. Examples of chemical adhesives include anionic asphalt emulsion, latex emulsion, resin-water emulsions, and calcium chloride. Chemical palliatives should be used only on mineral soils. When considering chemical application to suppress dust, consideration should be taken as to whether the chemical is biodegradable or water-soluble and what effect its application could have on the surrounding environment, including waterbodies and wildlife.

Table 1 shows application rates for some common spray-on adhesives, as recommended by Smolen et al. (1988).

Table 1. Application rates for spray-on adhesives (Source: Smolen et al., 1988)

| Spray-on Adhesive        | Water Dilution | Type of Nozzle | Application (gal/ac) |
|--------------------------|----------------|----------------|----------------------|
| Anionic Asphalt Emulsion | 7:1            | Coarse Spray   | 1,200                |
| Latex Emulsion           | 12.5:1         | Fine Spray     | 235                  |
| Resin in Water           | 4:1            | Fine Spray     | 300                  |

## Limitations

In areas where evaporation rates are high, water application to exposed soils may require near constant attention. If water is applied in excess, irrigation may create unwanted excess runoff from the site and possibly create conditions where vehicles could track mud onto public roads. Chemical

applications should be used sparingly and only on mineral soils (not muck soils) because their misuse can create additional surface water pollution from runoff or contaminate ground water. Chemical applications might also present a health risk if excessive amounts are used.

### **Maintenance Considerations**

Because dust controls are dependent on specific site and weather conditions, inspection and maintenance are unique for each site. Generally, however, dust control measures involving application of either water or chemicals require more monitoring than structural or vegetative controls to remain effective. If structural controls are used, they should be inspected for deterioration on a regular basis to ensure that they are still achieving their intended purpose.

### **Effectiveness**

- *Sprinkling/Irrigation*. Not available.
- *Vegetative Cover*. Not available.
- *Mulch*. Can reduce wind erosion by up to 80 percent.
- *Wind Breaks/Barriers*. For each foot of vertical height, an 8-to 10-foot deposition zone develops on the leeward side of the barrier. The permeability of the barrier will change its effectiveness at capturing windborne sediment.
- *Tillage*. Roughening the soil can reduce soil losses by approximately 80 percent in some situations.
- *Stone*. The sizes of the stone can affect the amount of erosion to take place. In areas of high wind, small stones are not as effective as 20 cm stones.
- *Spray-on Chemical Soil Treatments (palliatives)*. Effectiveness of polymer stabilization methods range from 70 percent to 90 percent, according to limited research.

### **Cost Considerations**

Chemical dust control measures can vary widely in cost, depending on specific needs of the site and level of dust control desired. One manufacturer of a chloride product estimated a cost of \$1,089 per acre for application to road surfaces, but cautioned that cost estimates without a specific site evaluation are rather inaccurate.

## References

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